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A SECOND LETTER From Mr. WOOD, TO THE COMMISSIONERS FOR REBUILDING The BRIDGE at *BRISTOL*, AND Opening the AVENUES to it.

BRISTOL:
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1760

BRITISH MUSEUM

A
SECOND LETTER
TO THE
Commissioners for rebuilding the Bridge at Bristol, &c.

GENTLEMEN,

I Have beſtow'd moſt of my Time, ſince I did myſelf the Honour to write my laſt to you, in conſidering, not only the Plan I then delivered, but the Scheme of rebuilding the Bridge, and opening the Avenues, in every Light it could occur to me; the Reſult of which Conſiderations I humbly beg Leave now to lay before you.

By the Act of Parliament there being a Proviſion made for a Temporary Bridge, and making good the Damages that may be done to St. *Nicholas* Church; an Intention of rebuilding the Bridge on the ſame Spot is pointed out; and therefore I will conſider a Plan of that kind, and endeavour to ſet the Difficulties and Inconveniences attending the Purſuit of ſuch a Deſign in as clear a Light before you as I poſſibly can; and then you will ſee, it was not without Reaſon I offered you the Plan I did.

To execute this Deſign an Expence of a Temporary Bridge, and pulling down and rebuilding or removing St. *Nicholas*-Gate, will be incurr'd, not to be ballanced even with the Oeconomy of making uſe of the old Foundation of the preſent Bridge; beſides the Approach from St. *Thomas-ſtreet* to *High-ſtreet* will be very aukward, having ſo many Angles, as you will ſee by the Plan herewith ſent you. I cannot ſee any Beauty in having a Gateway terminate ſo ſhort a Street as *High-ſtreet*; and if this Scheme be followed, I would adviſe St. *Nicholas*-Gate to be quite removed.

If a Temporary Bridge be built on the Eaſt Side of the preſent Bridge, it will be attended with great Inconveniences in paſſing from St. *Thomas-ſtreet* to *High-ſtreet*, ariſing from the Turning to get on it from the South, and off it, thro' St. *Nicholas*-Gate on the North Side; and this to be remedied but by one of theſe two Methods.

First, by pulling down *pro tempore* ſo much of the South-Eaſt End of *High-ſtreet* as will admit of a Paſſage to the Eaſt of *Nicholas*-Gate (another extraordinary Expence), and the pulling down that Gate will be attended with great Danger, and muſt put an entire Stop to the Paſſage into *High-ſtreet* whilſt about, unleſs as before there be a Paſſage to the Eaſt of it.

Or ſecondly, as my Deſign of the Terraſſes on the North and South Sides of the River will agree well with a Bridge built, either on the preſent Spot, or more to the Eaſt, if thoſe Terraſſes are firſt compleated, there will be a Communication between each Side of the Town during the rebuilding the Bridge, by a temporary one being thrown over the River, either at *Hawkins*'s-Lane, or on the Eaſt Side of the preſent Bridge.

THUS far have I conſider'd the Paſſage OVER the Bridge, and I flatter myſelf that few will blame me for thinking the moſt eligible Situation for ſuch a Paſſage to be on the Eaſt of the preſent Bridge. And to confirm this Opinion, I will now conſider the Conſtruction of the Bridge on the OLD Foundations only; for if a Bridge be built on NEW Foundations, there can be no Difference of Expence, whether it be built in the ſame Spot, or in a different Situation, only in reſpect to the Centers; and that is ſaving nothing at all equivalent to the Expence of a Temporary Bridge.

BUT before I proceed, I beg Leave to offer my Opinion of the old Foundations.

WAS the Bridge to be re-built of the ſame Width it is at preſent, there would be great Reaſon to uſe the ſame Foundations; but as it is to be ſo much wider, of Conſequence the Piers muſt be lengthened; and I humbly apprehend the Difficulty and Expence attending this additional Lengthening will be greater than is generally imagin'd, and the Difference of Expence between entire new Piers and this Scheme of PATCHING leſs than believ'd.

Beſides it will be attended with this ill Conſequence: The OLD and NEW Work can never be ſo united but the one muſt ſettle from the other, and a Settlement in the Foundation muſt be very fatal; every Day's Experience ſhews Workmen the Truth of this Fact; and I will appeal to every Man of Reaſon, whether it is not imprudent and contrary to the public Intereſt *even* to run the Riſk of ſuch a Settlement. Beſides when the *Old Piers* come to be taken down, I greatly fear, from the Thickneſs of them, that they will be found only a Caſing filled with rubble Work; as I found it in a Bridge (built about the ſame *Æra* with *Briſtol* Bridge) that I pulled down, at a Village call'd *Houghton* in *Lancaſhire* over a Branch of the *Ribble*, about ſeven Years ago; and if ſo, the Water will get into them, and they will become ſo rotten, that I am ſure I muſt appear very ignorant if I did not diſſuade you from making uſe of them.

THE Number of Cracks and Settlements, that are now ſeen, not only in the Baſtions of the Piers, but in the Piers themſelves, the rough Manner in which the Piers ſeem to have been caſed above low Water to near the Springing of the Arches, and ſeveral other Circumſtances that appear on a cloſe Survey of them, contribute much to confirm this Opinion of their being filled with rubble Work.

LONDON Bridge was (as STOW acquaints us) began to be built in the Year 1176, and finiſhed in the Year 1209, and the Courſe of the River for that Purpoſe was turned ſomewhere below *Weſtminſter* to *Rotherhith*, and the Remains of the Channel cut for that Purpoſe are ſtill to be ſeen in St. *George*'s Fields.

WHEN the Piers of that Bridge were taken down to widen the Arches, they were, as I am inform'd, found to be filled in the ſame Manner I conjecture *Briſtol* Bridge to be; and this Bridge being built not long after *London* Bridge, and the ſame Methods recorded to have been uſed in building it, there is all the Reaſon in the World to believe it to be built in the ſame Manner.

HOWEVER, to be certain of this, I humbly adviſe you, Gentlemen, to have one of the Piers *perforated* ſome *four* or *five* Feet above low Water, about *two Feet ſix Inches* wide and *three Feet ſix Inches* high, which may be done with Safety in the following Manner:

A Frame of Timber muſt be made, *two Feet ſix Inches* wide by *three Feet ſix Inches* high in the Clear, of Oak, *ſix Inches* in Front by *twelve Inches* deep; then the Frame will be *four Feet ſix Inches* by *three Feet ſix Inches* from out to out. A Groove *ſix Inches* deep muſt be carefully cut in the Side of the Pier, and this Frame let into it and well caulked on the Sides, the Inſide Edge of this Frame to have a *two Inch Rabbet*, and a ſubſtantial *two Inch* Oak Door well jointed and dovetailed together, to be hung as a Valve to the upper Side; now, as the Tide riſes, this Valve will be ſhut, and the Weight of Water will keep it cloſe and tight, ſo that no Water can get in during the whole *Flow* or *Ebb* of the Tide; provided the Workman will leave the *Rabbets* quite clean; and at low Water the Perforation may be made.

As I cannot by any Means adviſe the lengthening the *Piers* for the above Reaſons; the only Method I at preſent can think of to make uſe of the old Foundations, *ſuppoſing them to be firm and ſolid*, is as follows:

In the Drawing No. 2. Fig. 1. is a Plan of the *Redcliff Pier* as it now ſtands; and on it, a *Pier* deſcribed directly in the *Center*, which is the utmoſt Advantage that can be made of it; and here the Face of the *New Pier* from A to B, which will be the Upright of the *Pier*, after all the *Offsets* are made, cannot be more than *thirty-four Feet*.

In any Diviſion of the Arches, where the Face of a *New Pier* falls nearer the Face of the *old* one, it will not only be attended with the Inconveniency of being ſhorter than *thirty-four Feet*, but the Center of *Gravity* will be removed from the Center of the *Old Pier*, where it now ſtands, to *one Side*, and of Conſequence there will be great Danger of the *Piers* either *ſplitting* or *overſetting*.

This being the Caſe, I adviſe one ELLIPTICAL ARCH (of *one hundred and ten Feet Span* and to riſe *thirty-nine Feet)* to be turned from the Center of the *Redcliff Pier*, to the Center of St. *Nicholas Pier*, *thirty-four Feet* wide, as in *Drawing* No. 2, where *Fig.* 7 is the Plan. The Parts ſhadowed with *Yellow* repreſent the *Old Piers* as they now ſtand; I would ſtop up the *firſt Arch* on *each Side* of the River, by building Walls acroſs them as expreſs'd by the *Red Lines*; theſe *Walls* are to keep the *Redcliff* and St. *Nicholas Piers* in their preſent Situation, and from ſqueezing outward to the *Land* PIERS, and as it will be neceſſary to bring up an extraordinary Thickneſs of *Walling* on the *Eaſt* and *Weſt* Sides of the *Abutments*, to ſupport the *Foot* Ways, it will be proper ſlightly to *pile* the outward Walls marked A B. Tho' as they will have but little Weight on them, they will not be affected, by being on *new Foundations*.

THESE Walls will likewiſe ſerve as permanent Centers to the Arches, I purpoſe turning over the Openings, as repreſented in Fig. 8, under the Letters A B C.

THESE Arches thus turned will be a firm Foundation for the Abutments deſcribed in *Fig*. 7, by the *Black etched Lines*.

C C is the Face of the *Width* of the Arch, and ſtands directly on the Centers of the *old Piers*.

THE Lines D E, D E, repreſent the Face of a *Key Wall* to range with the *Cant* of the *Abutments* C D, C D, and to be continued, till it interſects the *Key Walls*, on each Side of the River, and to be built as high as thoſe *Key Walls*, in order to intercept the Current of the Water, both at *Ebb* and *Flow*, and turn it thro' the Center of the Arch in a proper Direction, and alſo to prevent too great a Weight of Water from preſſing againſt the *Abutments* of the *Arch* at high Water.

FIG. 8 is the Section of the Bridge from North to South, in which is ſhewn the Method of forming the *Centripetal Joints* of the *Arch* Stones: The *Curves* D E, D E, are formed from the *Centers* G and G, and the *Curve* E E, from the *Center* F; therefore the *Joints* at E and E being common to both the *Curves* D E, D E, and E E, the lateral Preſſure of the *whole Arch* is as regularly brought down to the ſpringing Stones D D, as if the whole Arch had been *Semicircular*.

I HAVE likewiſe repreſented the Method of filling up the *Abutments*, the only EFFECTUAL Way to ſtrengthen the Haunches of the *Arches*; the Letters O O O O *mark* the coping of the *Old Piers* above low Water.

THE yellow Line is the *Level* of the higheſt Tide ever known, and you will be pleas'd to obſerve, how little the *Water Way* is leſſened from low to high Water, by this ELLIPTICAL Curve, when compared to a Chord Arch of equal *Span* and *Altitude*, as repreſented by the red Lines; and here may be ſeen likewiſe how much the Cateral Preſſure of the *Chord Arch* exceeds that of the *Elliptical* one.

Now as the Arch is but *thirty-four Feet* wide, it will be inſufficient for a *Road* over it, unleſs the following *Invention* be approved of; which I am convinced will fully anſwer the Purpoſe: Allot *twenty-ſeven Feet* for the Carriage Road, and there will remain *three Feet ſix Inches* on each Side, then *Truſs* out on each Side *three Feet ſix Inches*, in the Manner I have drawn it *Fig.* 2, by which Means there will be Room for a Foot Path *ſix Feet wide* on each Side, and a *Stone Plinth* with a *ſtrong neat Iron Rail* along it.—Theſe *Truſſes* may run along the whole Bridge from Shore to Shore, or the *Abutments* may be thickened, *three Feet ſix Inches* on each Side, to ſupport theſe Foot Ways, as I have expreſs'd it in Drawing No. 3, and which Method I am for purſuing.

In the Drawing No. 2, I have endeavoured to expreſs the Methods of making, and ſetting theſe *Truſſes* in the ſtrongeſt Manner poſſible; they are to be *one Foot in Front*, *three Feet deep*, and *ſeven Feet long*, *half* of which will have a Bearing on the *Front* of the Bridge, as repreſented in Fig. 4. Theſe *Truſſes* are to be *three Feet aſunder*, and covered from *Center* to *Center*, with a *flat* PORTLAND Stone, *ſix Inches thick*, *four Feet long*, and *ſeven Feet wide*, which Stone is again to be covered with thin common *Pennant* of the Country. *Fig.* 3, repreſents the Front of theſe *Truſſes* together with the *Plint Courſe* and Part of the Iron Rails upon it, drawn to a large Scale. Now to prevent theſe *Truſſes* from tipping forward, I would have all that Part of them, that reſts upon the *Front* of the Bridge, *Joggled* from the Top to the Bottom as *Fig.* 6,

by

by which Means they will all become *inverted Wedges*, and if large *Blocks* of Stone of *three Feet Bed* and *three Feet deep* be placed between them Wedge-wiſe, and a *Bar of Iron* let into them *horizontally*, as repreſented in Fig. 5 *(with red Ink)*, and well *yeoted* with Lead, the whole will become ſo firm, that no Weight on the *Noſe* of the *Truſſes* can ever poſſibly overſet them; but to be certain I would have a *Chain-courſe* of Stone run the whole Length of the Bridge juſt under the *Tails* of theſe *Truſſes*, which may be *cramped* to them as repreſented in Fig. 4 *(with red Ink)*.

THE Drawing No. 3 is the *Front* of the Bridge as I would propoſe it; in which you ſee I have avoided all kind of Ornament, except a *Shield*, with the City *Arms* on the *Key* Stone.

THE Faces of the *Arch Stones*, which I would recommend to be of the beſt and ſtrongeſt Material that can be found, only to be broad-tooled, that the whole *Archivolt* may appear as one great *Bandage*, *projecting* at leaſt *ſix Inches* from the *Front* of the Bridge, and you will be pleas'd to obſerve that the *Truſſes* have the Look of a *Cornice*, and the Iron Rail on the Top will have a very *light* and *agreeable* Appearance.

THUS I have conſider'd a Plan for the Bridge, ſuppoſing the *old Piers* to be found *ſolid* and *firm*; which *Plan* may be as well executed on a new Foundation, with this Difference only, that inſtead of the *Truſſes* appearing as a *Cornice*, the Bridge will be ſo wide as to admit of a *real* Cornice. But in *either Caſe* I would recommend *Iron Rails* inſtead of a *Stone Balluſtrade*, not only as the moſt *ornamental*, but the *cheapeſt*, as I have found by Experience in my Buildings at *Bath*; and theſe *Rails* muſt run along the whole *Front* of the *Terraſſes* next the Water.

I BEG Leave to obſerve, that in my Deſign for the *Truſſes* there will be leſs *Workmanſhip* and *Stone* in them, than in the additional Part of the Bridge, ſuppoſing the *Arch* to be *forty-one* Feet wide.

I HAVE conſider'd of ſeveral other Methods of uſing the *old Foundations*, ſuppoſing them to be found *ſolid*, viz. with *four Arches*, with *two Arches*, and *four different* Ways with *three Arches*; but every Deſign is liable to ſome of theſe Objections, either *too expenſive*; or that the *Piers* fall not in the Center of the *old Piers*; or that the *Arches* muſt be unequal; which ought carefully to be avoided, as I ſhall preſently ſhew.

YOU will obſerve, that in all my Deſigns of the Bridges, I keep it very high, in order to give a ſufficient Paſſage under it at all Times of the Tide, by which the Navigation will receive the utmoſt Advantage.

I AM very ſenſible that it will appear to many, that this *raiſing* the Bridge will create a *great* Expence in the extraordinary Purchaſes of ſome Houſes in *Redcliff-ſtreet*, St. *Thomas-ſtreet*, and the *Back*; but if any one will take the Pains to calculate the preſent Value of the Houſes, and conſider the Extent of thoſe Houſes in Front, it will be very obvious that if a Number of compact Houſes be built on that Ground, the *improv'd* Ground Rents will fall not much ſhort of the Purchaſe, and the Advantage of the *Vaults* under the Streets will very well pay for the raiſing of them: But ſuppoſing the Expence to run very large, it never can be too great for that Advantage the Navigation will receive.

As to the *Hindrance* the Navigation will receive during the Building the Bridge, it is very plain, that the *Centers* to the *Elliptical* Arch, whether built on the OLD or NEW Foundations, may be ſo framed as to admit of a free Paſſage, thro' at leaſt TWO of the preſent Arches, during the whole Time.

I MUCH fear that if St. *Nicholas*-Gate be taken down, that the *whole Church* may be in Danger of falling; and if ſuch ſhould be the Caſe, the whole Charge of rebuilding it will fall on the Public, and therefore I think that Riſque ſhould not be run. But if it be the Reſolve of the Gentlemen to build the Bridge on the preſent Spot, I would, as I ſaid before, adviſe the Gate to be taken down and to be removed, and there is Ground ſufficient to enlarge the Church; a Deſign for which, if deſir'd, I am ready to give.

IN Drawing No. 1 you have the Bridge and Streets as they are at preſent, with the

Lines of Buildings in red Ink; and No. 4 is the *Plan* diveſted of the old *Lines*, ſuppoſing the Bridge to be built in the ſame Spot it is in at preſent.

I WILL not perplex you, Gentlemen, with the Deſcription of *framing of Centers*, *driving of Piles*, or with any other Part of the *Mechanical* Operations neceſſary to *build a Bridge*; the good and great Examples of that kind of Work in *Weſtminſter*, and other Bridges in the Kingdom, having made thoſe Things *familiar* to almoſt every *good Carpenter* and *Maſon*; and though I would not trouble you with a Diſſertation on *Arches*, yet I cannot help laying the following *Axioms* before you.

1. ARCHES are a *Geometrical* Contrivance to cover large *Apertures* with ſmall non-elaſtic Materials, either to ſupport a great Weight, or to make a Road, as in Bridges over Rivers.

2. THE Properties of *Arches of Maſonry* are independent of thoſe of *Curves*.

3. THE Strength of Arches chiefly depend, 1ſt, on all the Arch Stones being of equal Size, as thereby the *Geometric Principles*, on which the *Arches* are built, operate moſt equally in every Part, 2dly, on all the Joints of the Arch Stones being *Centripetal*, and every Part of them *Concentric*.

4. ALL *Arch Stones* to increaſe in Length in Proportion to the *Diameter* of the *Circle* of which the *Curve* of the *Arch* is a *Segment*, and their Thickneſs to be determined by the *Hardneſs*, or *Softneſs* of the Materials: *Hard*

Materials requiring *leſs* Thickneſs, all Arches built with them become more truly *Geometrical.*

5. All the Arch Stones ſhould operate freely, otherwiſe the *Geometric Principles* of the Conſtruction of the Arch are deſtroyed, and if therefore the Stones are united by *Joggling*, or other Means, 'tis on the Strength of the Materials only, that the *Strength* of the *Arch* depends.

6. All Foundations ſhould be *preſſed* as equally as poſſible, and all *Piers* ſhould have the *Centers of Gravity* as near the *Center* of *them* as poſſible; therefore *unequal* Arches in the ſame Bridge are improper, as the *Pier* that ſupports them, has not the *Weight* in the *Center*; and if more than *three Arches*, the *Bed* of the River muſt certainly be unequally preſſed.

7. If one Arch ſpring from an *Old Foundation* on one Side, and a *new one* on the other, 'twill be a *Matter of Wonder*, if that Arch does not fall.

8. All Bridges, if the Water riſes high on the *Spandrels* of the *Arches*, are in much Danger from the Force of the Current.

9. Semicircular Arches, or ſuch Arches that are compoſed of ſeveral Segments of Circles that ſpring from a Level with the Center, have the leaſt lateral Preſſure.

As to the Materials proper to be uſed in building the Bridge; the Arch Stones I would adviſe to be of *Portland*, the *Goodneſs* of that

Material being ſufficiently proved; there is indeed a *Stone* at *Doulton*, near *Shepton-Mallet*, of which the *Cathedral of Wells* is built, that is of a very *hard* Texture. And if a ſufficient Quantity of it could be got, I imagine it would anſwer the Purpoſe very well, and will be cheaper than the *Portland*, both in *Workmanſhip*, and in the Value of the *Stone*. The *Fronts* may be of *Bath* Stone, and the *Abutments* filled up with a *Stone* that comes from about *Hannam*; and from Experience I can recommend the *Hannam* Lime, burnt from the white *Elias* Stone and Coal Aſhes, well beat and tempered, to be the beſt *Cement* known.—But it muſt be obſerved that all the *Arch Stones* muſt be of the *ſame Material*, chooſe which you will.

Tho' it is my Opinion that the *Elliptical Arch* now offer'd is the moſt *eligible*, to be executed, either on the *old*, or on a *new Foundation*; yet the Plan of *three Arches*, I before delivered, may be executed on a new Foundation without much Interruption of the Navigation, during its building, by keeping it as near as poſſible the *Redcliff Shore*.

On the whole, when you conſider the Uncertainty of the *Solidity* of the *Old Piers*; the Contrivances that muſt be made uſe of, to make the Bridge wide enough, if they are found *firm*; the great Expence of a TEMPORARY Bridge, the Expence that may be incurred by pulling down St. *Nicholas*-Gate; the *Awkwardneſs* of the Paſſage over the Bridge and the Avenues to it; I ſay, when all theſe Things are conſidered, you muſt, with me, think a Bridge to the Eaſt of the preſent the beſt Scheme; but reſolve on which you pleaſe, I am ready, as an Architect, to obey and aſſiſt you to the beſt of my Power.

I FLATTER myſelf that my own Experience in *laying out* ground for building to the beſt Advantage, and the Knowledge in that Branch, I have received from my late Father, (no Stranger to this City) enables me to be of great Service to you in that particular Branch; a Method for you to purſue I have beſtowed ſome Thoughts on, and have formed a Plan, and prepared a Draught for *building Leaſſes*, with ſuch Covenants, as I know *experimentally* to be the *propereſt* for ſuch; and which, if deſired, I am ready to lay before you. For I do not confine myſelf, by offering a Plan meerly to the building the Bridge, but propoſe laying out, and dividing the Ground of the Avenues to the Bridge, and making *particular* Plans of each *particular Houſe*, and aſſiſting you with my beſt Advice in diſpoſing of ſuch Ground to the beſt Advantage, and ſeeing the whole properly executed.

MY perſonal Acquaintance with the *Commiſſioners* being very *confined*, and my being obliged to attend my Duty *here*, forces me again to obſerve, that my *Plan* appears before you *unſupported* by Intereſt; but as your *Advertiſement* was a public Invitation to all the Artiſts in the Kingdom to offer their Service, it is a Matter of great Satisfaction, to conclude from ſuch a public Invitation, that your Choice of an Architect will be determin'd *not by Intereſt*, but by *Merit*; of which tho' I have little Boaſt, yet it is a great Pleaſure to reflect, that my *Plans* will have an *impartial Verdict* paſs'd on them; and I make no Doubt you will chooſe the beſt for the *public* Intereſt; and if you think any *other Plan* more *eligible* than mine, or any other Perſon more *capable* of giving you Aſſiſtance, I ſhould be aſham'd even of deſiring to be imploy'd to the Diſ-ſervice of the Public by having my Advice followed. I am,

GENTLEMEN,

Your Moſt Obedient Humble Servant,

JOHN WOOD.

WELLS, *Auguſt* 20, 1760.

* * *

POSTSCRIPT.

I HAVE not deliver'd any Eſtimates of the Bridges, not knowing which you would fix on; but this general Rule be pleas'd to obſerve, that three Twenty Feet Arches are cheaper than one Sixty Foot Arch, and Five 12 Feet Arches cheaper than Three Twenty

Feet Arches, *ſuppoſing* all to ſpring from the ſame Level; but conſider the whole Bridge together, there will be no *great* Difference of Expence between a *ſingle Arch* and *Three Arches*, provided they cover equal Ground and are *equally high*. I forgot to mention in my laſt Letter, that I propos'd *Vaults* under the Terraſs on the South Side of the River, as well as under *that* on the North Side; the Advantages of which will amply pay the Expence of raiſing *thoſe Terraſſes*, and even the Streets in that Method.

BRITISH MUSEUM

J. W.

FINIS.